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ABSTRACT

Evidence indicates that the anticipated Information Technology (IT) revolution in United Kingdom (UK) schools has not occurred. The ImpacT study evaluated the effect of IT on children's achievements in UK primary and secondary schools. The research revealed that IT can make significant contributions to teaching and learning, but a variety of inhibitors are still limiting the scope of impact. IT was found to have a positive impact on children's achievements, but this was not consistent across subjects or age ranges. This positive impact was difficult to separate from other such factors as pupil access and opportunity, teacher ability, and school and LEA (Local Education Authority) support. Of the subject areas studied, IT contribution was especially significant in mathematics, geography, and primary English. The results were influenced by the extent of use and integration of IT into subject teaching and pointed towards the existence of a "minimum threshold of IT use" before the impact of IT could be detected. The contribution of IT was in terms of increased motivation, concentration, and more challenging learning situations. (Contains 13 references.) (Author/AEF)

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An IT Revolution in UK Schools?

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Abstract

Evidence indicates that the anticipated IT revolution in UK schools has not occured. Change has been patchy and inconsistent. A national research project found that IT can have a beneficial effect upon teaching and learning, but also a range of inhibitors to widespread use. Detectable impact appears to depend on a minimum threshold of IT use, teacher innovators, and an associated embedded philosophical underpinning.

Introduction

Many initiatives in various countries have attempted to foster the use of IT in schools. The UK has been no exception. Despite claims that an IT revolution has taken place, it is not easy to detect educational outcomes. The key question is "has IT influenced the nature of teaching and learning in classrooms?" This paper reports how a research project has provided some findings which enable us to have a greater understanding of the reality behind the rhetoric.

The National Scene

For over a decade the Department of Education and Science (DES) has followed a strategy to enhance the quality of teaching and learning across the curriculum through the use of IT in schools. Two national projects, the Microelectronics Education Programme (MEP 1981-6) and the Microelectronics Education Support Unit (1986-9), provided funds for software development, teacher training and an information base. The current New Information Technology for Schools programme provides grants for professional support for specialist IT advisers in Local Education Authorities (LEAs) and Teacher Training establishments. Substantial support for equipment and training has been provided also by the Department of Trade and Industry (DTI), the Department of Employment and LEAs, schools, governors and parents.

Throughout this period, the use of computers has changed. A clear justification for the expenditure from the DES and DTI was to train computer scientists and a computer literate population. In this sense the rationale behind the introduction of IT into schools was as much vocational as pedagogic (Hawkridge 1990). Richard Fothergill, director of MEP said in 1981 that the main purpose of the programme was "to prepare pupils for a world in which devices based on microelectronics were commonplace".

In the early and mid-eighties, computer science examinations and computer awareness courses flourished. There was however a growing awareness that pupils should use IT for learning their main subjects, rather than treating IT as a separate subject (Watson 1987). A national document, Information Technology 5-16 (HMI 1987), with an emphasis on IT as a vehicle for enhancing teaching and learning, laid the foundations for the style of IT to be associated with our new National Curriculum.

Until 1988, schools in the UK were not prescribed what was to be taught; they had complete autonomy over the curriculum content of their classrooms. Although public examinations, set by university boards, at 16 years and 18 years had a major unifying effect, pupils could move and find no cohesion between the curriculum in their old and new schools. While this autonomy was a breeding ground for innovative curriculum developers, the problems thus created were substantial. In particular there was no minimum entitlement in terms of curriculum base and attainment expectancy for pupils. In 1988 the government passed an Education Reform Bill which has had a major effect on all aspects of school life, from management and financing, to curriculum and assessment.

IT was placed within this National Curriculum as a specific Attainment Target with an associated Programme of Study within the Technology document, aimed at developing IT capability; but IT also appeared within the Statements of Attainment and Programmes of Study of other subjects—mathematics, science, English, history, geography, and modern foreign

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languages. Thus IT was to permeate all the curriculum, and not just be a separate entity. All schools were advised that they were required to appoint an IT coordinator and produce a whole school IT policy.

Thus after a decade of endeavour, IT in schools was placed firmly in two arenas, a technological capability which every adult required, and Computer Assisted Learning. While we in the CAL field laud this cross-curricular approach, IT is virtually the only subject in the NC that has been so identified. Thus it still stands outside mainstream perceptions which are now so dominated by the articulations of programmes of study of separate subjects.

Evidence of Use in Schools

The DES has carried out statistical surveys of the use of IT in schools every two years since 1986. From these useful information can be gleaned; for instance, by March 1992:

- primary schools (ages 5-11 years) had on average 7 computers, and a pupil: micro ratio of 25:1. This compares with 2.5 computers and a ratio of 67:1 in 1988;
- secondary schools (ages 11-18) had on average 58 computers and a pupil: micro ratio of 13:1. This compares with 23.2 computers and a ratio of 32:1 in 1988;
- the percentage of primary staff confident in IT use was 72% compared with 56% in 1988. In secondary schools the figures were 53% in 1992 and 48% in 1988;
- 90% of primary teachers and over 80% of secondary teachers had received basic IT awareness training. Over half of all teachers had attended more in-depth courses;
- about a third of primary schools, and a third of secondary heads of department reported that IT had made a substantial contribution to teaching and learning; about two thirds said IT had made some contribution.

On this basis, the DES tends to make statements to the effect that "the UK is a leader in the field." But counting hardware, ratios of micro per pupil and the number of training courses attended, tells us little about the actual IT use by pupils in school.

Further examination of the data reveals a worse picture. In 1992, IT's contribution to teaching and learning in secondary schools was particularly marked in business and computing studies. But the reported contribution of IT to other subjects, such as the sciences, mathematics, and geography, was considerably less. Indeed, across all subjects, only 17% reported "substantial" use was made of IT in their teaching, 30% reported "none", and the remaining 53% reported "some". Note however that "some" and "substantial" are not defined by the survey; one or two lessons a year could be reported in this category. Thus the actual curriculum use of IT by teachers is still small.

Her Majesties Inspectorate (HMI), an independent body of school inspectors, make regular curriculum reports based on detailed visits and consultations nationwide. Recent reports (1990, 1992) identified "some" interesting use of IT in nearly every subject of the curriculum, at best leading to an enhancement of study. But the secondary school report shows that, while many pupils can competently manipulate text and pictures, and some can carry out investigations using data, very few can use IT to carry out scientific experiments, and that insufficient attention is given to exploring computer models and simulations.

In general HMI's findings show that, as the need to breed confidence and familiarity with IT has diminished, and as the implications of the NC for IT in a range of subjects have begun to be felt, schools have not yet translated this into any substantive action within classrooms. These findings are unfortunately very similar to those they reported in 1986.

Research into the uses of IT in education have included studies on the effects in particular subject areas, on collaborative learning, of particular types of software on children's learning, and classroom management of IT. Some involved studies of the uses of computers in different educational contexts, for example 'Information technology and group work in physics' (Howe et al.1991), or research into the uptake of computers in schools—Cox and Rhodes (1990), Plomp and Moonen (1991). Some small studies focussed on a single curriculum area (Hoyles and Sutherland 1987, Martin and Smyth 1987) while other larger studies covered a range of concept and skill learning. Over 250 studies have been reported in the literature (Niemiec and Walburg 1992) on the effects of IT on pupils' learning of particular skills and concepts.

These research findings provide evidence of the positive effects of the use of IT on pupils' learning, for example, that pupils develop skills in writing through the use of word processors, or develop a greater understanding of mathematical concepts through the use of LOGO. However, there had not been a large scale comprehensive and longitudinal study of pupils' achievements using IT. Such a study was particularly timely in the UK and needed to address the conundrum of why,

despite reported benefits and substantial investment, a real revolution in terms of the use of IT in schools was still not apparent.

Within this context, the ImpacT study was commissioned and designed.

The ImpacT Project

The Research Design

The ImpacT study, an evaluation of the Impact of Information Technology on children's achievements in primary and secondary schools, ran from 1st January 1989—31st December 1991. The work commissioned by the DES was carried out by a team of researchers in the Centre for Educational Studies, Kings College, University of London (Watson 1993). The focus of the research was on pupils' learning and classroom activity involving IT in the school age bands 8-10, 12-14, and 14-16, in the subject areas of mathematics, science, geography and English. This was the first in-depth investigation undertaken which focussed on the impact of IT across a broad age band and range of school subjects.

A large field study was designed involving over 2,300 pupils from 87 classes in 19 LEAs, distributed geographically in England and Wales. These pupils came from matched pairs of classes. These classes were nominated for their good teaching and curriculum delivery; one of each pair was also identified as making regular use of IT and so was designated HiIT, while the other was identified as LoIT. The pupils thus divided into a matrix of 12 cells; three age groups, 8-10, 12-14, and 14-16, and the four curriculum subject areas. This sample was used in a research framework that had three substantial parts.

- An assessment of pupil's achievements of specific learning tasks and skills, through the administration of specifically designed subject-focussed assessments to the matched pairs of classes in each cell. These reasoning-in -subject assessments were supplemented by topic-specific mini-studies in some pairs and also some HiIT-only classes, and a final test for IT concepts and skills. Statistical comparisons of test performance were adjusted through the use of general ability assessments.

- In-depth longitudinal case studies in a few HiIT classes were focussed on classroom processes and pupil interactions. Classrooms were observed, pupils and teachers were questioned, and documentary evidence was gathered to provide illumination on classroom realities. Qualitative analysis was based on those themes and issues that emerged from the data.

- IT resourcing and use was monitored throughout by the regular returns of questionnaires and data sheets from the teachers and pupils in each class. Hardware and software provision, pupils' IT use in ImpacT subject and across all subjects and pupils' extra-mural use were analysed descriptively by classes, age cohorts and subjects.

The Findings

The results from the three parts were integrated to address three main questions:

- Did IT make a contribution to pupils' learning?

- Does incorporating IT affect the planning and practice of teaching?

- What were the organisational demands of IT on the schools?

A Contribution to Pupils' Learning

IT did make a contribution to learning, but this was not consistent across subjects or age bands. Data supporting this was from subject reasoning assessments and topic specific mini-studies. The focus of the subject reasoning assessments was on higher order processes and thinking in each subject; for example, relational thinking in mathematics, formulating hypotheses in science, drawing inferences from map, graphical and photographic information in geography, and aspects of cohesion in pupils' writing in English.

The most dramatic results came from mathematics and geography in the 14-16 age band. There was some evidence in support of the use of IT in primary English; the case for IT in science was not supported.The overall effect for reasoning in subjects, age by subject combined, was statistically significant in favour of the HiIT group. As an indication of the relative size of the effect, this difference was in the order of an equivalent contribution of a mean success rate on a public examination of 52.8% by the HiIT group compared with 47.2% by the LoIT group.

Actually the results from a small number of the HiIT classes provided the main evidence for these findings. Access and use in these classes suggested there was a minimum threshold of IT use for the impact to be detected.

Five of the eight topic-specific mini-studies provided evidence of IT use contributing to learning; in each case the contribution was in terms of higher level processes or thinking. For example, in the mathematics mini-study on angles the two classes were studying the same materials, with the pupils in the HiIT class also working with LOGO. The HiIT class achieved significantly higher results, with the main contribution being to the application of the concepts and relationships.

The main focus of the case study research was on classroom processes. This research must be qualified in that while the data collection was rigourous and detailed, the analysis was designed to provide exemplification rather than generalisations. Selected observations suggested considerations which supported and extended results from the assessments. For example:

- computers were found to be good motivators which heightened pupils' interest and enjoyment and were also seen to have a positive effect upon the status of the subject;
- computers aided concentration by focussing pupils' attention on the work in hand and as a result some pupils and teachers believed that the standard of work produced was of a higher quality than it would have been otherwise;
- opportunities to work in an open-ended way enabled pupils to become involved in more complex and challenging learning situations beyond that typically experienced.

Some of the failures to detect any effect of IT use may be related to problems encountered in case study classes:

- difficulties in using a particular software package;
- inability to work effectively in a collaborative environment.

The case study analyses also indicated a critical element in the notion of HiIT—this was the importance of the interaction or interplay between hardware/software availability and use, and the role of classroom organisation and management and teaching styles.

The Effects on Pedagogy and Practice

The planning and practice of teachers using IT involved a consideration of classroom management and organisation, teaching styles, and hardware and software availability and use. The results from the case studies, mini-studies, and IT use indicated that the most important factor was the role of the teacher.

Careful attention to organisation and management, in particular the effective use of collaborative or group work, was important. Effective use of IT required substantial knowledge and understanding of, and familiarisation with, a variety of software in order to integrate the activity, in philosophical and pedagogical terms, with a larger scheme of work.

General purpose software, such as spreadsheets and databases, placed additional demands on the teacher, beyond that of familiarity with more complex software. These included more reflection on the nature of the subject and the potential role of such software in enhancing processes and understanding.

The Demands of IT on Schools

Even in those schools with a policy for allocation of resources and in which there was a higher than average number of computers, there were often problems with equity in access (timetabling, booking of a computer or the computer laboratory). In primary schools this was compounded by the small number available to the class at any one time, as computers were often located one per room rather than in clusters. In secondary schools this was compounded by the constraints due to demands of particular subject areas, e.g. business studies. Whilst a school policy was found to be important, this was not sufficient in itself; the use of IT was dependent upon the interest of individual teachers and/or departments.

The case studies suggested that the interest and support from Head teachers was a factor, but that this could be described as 'letting the teacher get on with it', rather than a more pro-active stand in favour of the integration and implementation of IT. The support of Head teachers was important in the acquisition of equipment and in the targeting for particular funds. It was important for the teachers to feel they were supported by the senior staff.

Concerns expressed by teachers in the IT use data and case studies indicated that many needed an on-going programme of in-service training, if they were to make regular use of computers in their teaching and exploit the potential offered by some software.

Implications of Findings for Resources and Policies

The issues raised by these findings are complex and not easily reduced to specific short term recommendations for which the research was not designed. The results do however indicate areas which need covering in any strategy for enhancing the educational opportunities for all pupils through IT.

Learning

There was a minimum threshold of IT access, experience and use necessary for the contribution to pupils' learning to be apparent. This threshold involves more than a workable pupil/computer ratio; current provision of hardware resources in most schools is not sufficient.

Not all pupils were provided with opportunities to take advantage of the potential of a full range of software. Access and time must be considered not merely in terms of in class, but also other in-school, out-of-class opportunities, through open-access learning resource areas or libraries.Software used for exploratory or enquiry focussed work provided pupils with opportunities to take decisions and make choices which promoted higher level learning outcomes. Collaborative work by pupils was an important dimension, but many pupils found it difficult to engage in this activity; they need to learn how to work effectively in such contexts.

Teachers and Pedagogy

Although some teachers made effective use of IT, there was seldom any cascade of their experience and expertise, even with highly supportive colleagues in the subject peer group. Teachers would benefit from more planned opportunities to share their experiences of using IT.

Particular pedagogic skills and understandings of teachers appeared to contribute to their effective use of IT, including their view of their subject, a balance between knowledge and process, and confidence, classroom organisation and management skills, and teaching styles.

School Resources and Policies

Individual school policies seldom included long term projections or goals consistent with the intended role technology across the school. The current level of provision and related demands from some teachers were in conflict with a distribution which was both equitable and adequate for individual teacher demands.

Most whole school policies for IT were not producing cooperative efforts across school subjects in a systematic and coordinated fashion. Nor do they provide on-going opportunities for reinforcing and extending pupils' IT capability.

In-service training should focus on the development of a philosophical underpinning, both of school subject and the potential supporting role of software, and the development of classroom organisational and management skills, and teaching styles conducive to more open-ended and collaborative work by pupils.

Conclusion

This research has shown that IT can make significant contributions to teaching and learning, but that a variety of inhibitors are still limiting the scope of impact. In particular, that:

- IT has had a positive impact on children's achievements, but this was not consistent across subjects or age-bands;
- this positive impact was difficult to separate from other such factors as pupil access and opportunity, teacher ability, and school and LEA support;
- that of the subject areas studied, the contribution of IT was especially significant in mathematics, geography and primary English;
- the results were influenced by the extent of use and integration of IT into subject teaching;
- the results pointed towards the existence of a "minimum threshold of IT use" before the Impact of IT could be detected;
- the contribution of IT was in terms of increased motivation, concentration and more challenging learning situations;

- the evidence pointed to the need for an on-going programme of in-service training, covering not just hardware and software, but providing a philosophical underpinning in terms of school subjects, and teaching, organisational and classroom management skills.

Thus in spite of a number of commendable efforts and a sustained national strategy for the implementation of IT in education, people at all levels needed more help in formulating clear policies and strategies; this should go beyond focussing on particular aspects of issues and problems and provide a comprehensive and long term view to take full advantage of the potential impact of IT on pupils' learning.

This research confirms that if schools are to build successfully upon the foundations of awareness and basic skills, then they must ensure that the use of IT is led by subject considerations rather than by the impetus of enthusiasm for IT alone.

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